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Perfect Social Media Image Posts: symmetry and contrast influence consumer response

Abstract

Purpose: Two studies investigate how different structural properties of images – symmetry (vertical and horizontal) and image contrast – affect social media marketing outcomes of consumer liking and engagement.

Methodology: In Study 1's experiment, 361 participants responded to social media marketing images that varied in vertical or horizontal symmetry and level of image contrast. Study 2 analyzes field data on 610 Instagram posts.

Findings: Study 1 demonstrates that vertical or horizontal symmetry and high image contrast increase consumer liking of social media marketing images, and that processing fluency and aesthetic response mediate these relationships. Study 2 reveals that symmetry and high image contrast improve consumer engagement on social media (number of “likes” and comments).

Research implications: These studies extend theory regarding processing fluency's and aesthetic response's role in consumer outcomes within social media marketing. Image posts' structural properties affect processing fluency and aesthetic response without altering brand information or advertising content.

Practical implications: Because consumer liking of marketing communications (e.g., social media posts) predicts persuasion and sales, results should help marketers design more effective posts and achieve brand-building and behavioral objectives. Based on the results, marketers are urged to consider the processing fluency and aesthetic response associated with any image developed for social media marketing.

Originality: Addressing the lack of empirical investigations in the existing literature, the reported studies demonstrate that effects of symmetry and image contrast in generating liking are driven by processing fluency and aesthetic response. Additionally, these studies establish novel effects of images' structural properties on consumer engagement with brand-based social media marketing communications.

Keywords: social media marketing, processing fluency, audience engagement, consumer liking, experimental aesthetics, symmetry, image contrast

Introduction

Consumers prefer image- to text-centric social media posts; thus, visual-based social media platforms (e.g., Instagram and Snapchat) continue to grow (Appel *et al.*, 2020; Ji *et al.*, 2019). Meanwhile, text-centric platforms (e.g., Twitter) now allow users to incorporate more images into posts. Even online dating has shifted from lengthy personality profiles to choices driven by a few attractive images in apps such as Tinder, Bumble, Grindr and Happn. Social media images also play a growing role in brand-building and marketing as businesses compete for consumer responses, such as engagement or liking. Marketers emphasize social media post design, because when consumers more actively engage with a brand's social media posts, their brand loyal increases (Fernandes and Castro, 2020).

Unfortunately, how social media marketing images shape consumer responses remains insufficiently studied. However, researchers have conceptually posited that certain structural properties of images (e.g., simplicity, symmetry, or image contrast) directly influence aesthetic responses (i.e., aesthetic appreciation and judgments that an image is beautiful) and consumer liking of that image (Berlyne, 1974; Bloch, 1995; Hayn-Leichsenring *et al.*, 2017; Marin *et al.*, 2016; Redies *et al.*, 2020; Zarzosa and Huhmann, 2019), whereas others suggest that such effects can be explained via processing fluency (Brinol *et al.*, 2006; Reber *et al.*, 2004a; Reber *et al.*, 2004b; Schwarz, 2018), but treat judgments of beauty and liking as equivalent concepts (Graf and Landwehr, 2017; Labroo and Pocheptsova, 2016). However, neuroimaging studies suggest that judgments of beauty and liking are processed in different regions of the brain (see Marin *et al.*, 2016 for review), which suggests that they are separate but related constructs. Unfortunately, the relationship among these responses to the structural properties of images remain largely untested empirically, especially in social media marketing.

The current research synthesizes these alternative theoretical approaches based in experimental aesthetics/neuroaesthetics and cognitive psychology, then presents two studies that examine how symmetry and image contrast affect consumer response to social media marketing messages. First, a controlled experiment tests a theoretical framework of the direct and indirect effects of structural properties (symmetry and image contrast) on consumer liking with indirect effects serially mediated by processing fluency and, in turn, aesthetic responses. Further, this experiment compares vertical versus horizontal symmetry to determine whether effects are specific to type of symmetry. Second, a field study of actual social media posts determines whether symmetry and image contrast elicit greater “liking” and more comments from consumers. Importantly, consumer liking of marketing communications (e.g., social media posts or advertisements) is the best predictor of outcomes important to practitioners – persuasion and sales (Smit *et al.*, 2006).

The current research accomplishes four goals. (1) It is one of the first empirical studies to demonstrate that processing fluency and aesthetic response both drive the effects of images’ structural properties (symmetry and image contrast) in generating liking (see Table 1). (2) It establishes novel effects of images’ structural properties on consumer engagement (i.e., “likes” and comments) with brand-generated social media marketing content. (3) It compares whether these effects are generalizable across types of symmetry (vertical and horizontal). (4) It also compares symmetry’s effect to that of image contrast to determine whether effects are generalizable across structural properties.

<<Insert Table 1 about here>>

Theoretical background

When exposed to marketing communications emanating from brands, consumers might experience a hedonic response that can be described as *liking* (Smit *et al.*, 2006). Liking is defined as a favorable evaluative response based on affective pleasure derived from a stimulus, such as a social media post (Graf and Landwehr, 2017; Huhmann and Albinsson, 2012; Marin *et al.*, 2016). Consumers' liking of brand communications (or lack thereof) has broad implications for marketers. When brand communications are well-liked, consumers are more inclined to attend to brand information, develop more positive attitudes towards the message and brand, as well as higher purchase intentions (for a review, see Huhmann and Albinsson, 2012; Smit *et al.*, 2006). In the context of social media platforms ubiquitous in the modern marketplace, liking has been closely linked to consumer engagement with social media content (Halaszovich and Nel, 2017).

Social media users respond differently to image-centric and text-centric content (McShane *et al.*, 2019; Noguti, 2016). To help practitioners design more effective social media messages, research is required to determine how structural properties of images impact consumer liking of brand-generated social media content, and what underlying mechanisms explain their impact on consumers' response. Based on evidence from other fields – specifically, cognitive psychology, experimental aesthetics, and neuroaesthetics – we posit that symmetry and image contrast might be two structural properties that affect consumers' liking of brand-generated social media content, and that this relationship depends on two underlying mechanisms: processing fluency and aesthetic response. Following sections explore this notion in more detail.

Consumer Liking and Symmetry

Symmetry is defined as “self-similarity under a class of transformations <such as> translations, rotations, and reflections” (Wagemans, 1997, p. 346). For the purposes of this research, we will define symmetry as self-similarity within a social media image. Prior studies described symmetry processing as an automatic visual process (Treder, 2010). While humans are capable of efficiently detecting different types of symmetry, most studies on visual perception focus on mirror symmetry due to its “special status” in the human visual detection system as the most salient form of symmetry (Pecchinenda *et al.*, 2014; Wagemans, 1995). An object that possesses mirror symmetry has “at least one symmetry axis ... that splits the object into two identical but mirror-inverted halves” (Treder, 2010, p. 1512). For example, this can involve a reflection around a vertical axis (as in the letters “A” or “V”) or a horizontal axis (as in the letters “E” or “D”) (Reber *et al.*, 2004a; Treder, 2010).

Overall, such mirror symmetry is effortless and rapid to detect via fast, holistic process of global symmetry detection, while other forms of symmetry require much more cognitive effort (Wagemans, 1995). However, the orientation of the mirror symmetry axis impacts the speed and ease of detection. While prior research has shown conflicting findings, the literature suggests that the axis orientation from the easiest to the most difficult ones to detect are as follows: vertical axis > horizontal axis > diagonal axis > other oblique axes (Bode *et al.*, 2017; Pecchinenda *et al.*, 2014; Wagemans, 1997). It must be noted that perfect mirror symmetry is rare in real world – yet, the process of symmetry detection in humans is incredibly robust and noise-resistant (Treder, 2010; Wagemans, 1997). Because the symmetry of an object is assessed rather rapidly, there is no point-by-point comparison, and large perturbations can be tolerated. In fact, in complex and dense patterns, only 30-40% of pairwise correspondence is sufficient to trigger

symmetry detection (Wagemans, 1995). In short, a quick effortless visual assessment can indicate that an object is symmetrical – and the implications of such process are of theoretical and practical significance.

This is because symmetrical objects are typically preferred to the non-symmetrical ones (Berlyne, 1974; Wang and Hsu, 2020). Preference for symmetry is inherent and strong (Creusen *et al.*, 2010; Tinio and Leder, 2009), and holds for both actual objects and abstract stimuli (Shepherd and Bar, 2011). Symmetry in images should positively affect viewers' preference, pleasure, or liking (Bode *et al.*, 2017; Reber *et al.*, 2004a; Redies *et al.*, 2020). In marketing, mirror symmetry in brand logos has been shown to positively influence consumer liking and interest (Henderson and Cote, 1998; van der Lans *et al.*, 2009). In product design, smartwatch interfaces elicited higher liking when symmetrical rather than asymmetrical (Wang and Hsu, 2020). In the online environment, websites symmetrical around a vertical axis influenced perceptions of simplicity, diversity, and craftsmanship (Seckler *et al.*, 2015). Although not previously investigated in social media research, we propose that social media images that feature mirror symmetry around a vertical or a horizontal axis (most salient symmetry types) will generate favorable consumer responses to social media posts in the form of liking:

H1a: Social media images with vertical symmetry will elicit more liking than non-symmetrical images.

H1b: Social media images with horizontal symmetry will elicit more liking than non-symmetrical images.

Consumer Liking and Contrast

Another structural property of images is contrast. Image contrast is the amount of difference in brightness or luminance between light and dark areas, or the range of intensity levels from the lightest to the darkest tones. In the current research context, image contrast will involve overall or global intensity levels in photographic images in social media posts.

The literature identifies a few varieties of contrast. First, figure-ground contrast involves the ability to distinguish a foreground object from its background setting (Kim and Lakshmanan, 2015). Stimuli used to examine figure-ground contrast typically involve simple solids (e.g., circles or bars) against a uniform background (Broggin *et al.*, 2012; Reber *et al.*, 1998; Reber *et al.*, 2004b). The ability to distinguish the figure from the background can be enhanced as visual noise, which reduces visual clarity, is removed or takes on a more regular pattern (Chinnis and Uttal, 1973; Machilsen *et al.*, 2009). Figure-ground contrast can also be enhanced through greater color or brightness differences between bordering elements (Sohn *et al.*, 2017).

Second, image contrast concerns the luminance or brightness based on the intensity of colors or greyscale pixels in digital images (or halftone dots in print images). Image contrast has been examined as either local or global image contrast. Local image contrast involves the difference in brightness between each pixel (or dot) location and the neighboring locations. Global image contrast is the difference between light and dark areas, or the distribution of intensity levels of luminance, throughout the entire image (Dijkstra and van Dongen, 2017; Ortiz-Jaramillo *et al.*, 2018; Pedersen *et al.*, 2010; Simone, 2016). Given the current research's focus on entire images appearing in social media marketing, the current study will examine effects of global image contrast.

Like symmetry, higher contrast should increase liking of social media images. Unfortunately, little research has investigated responses to image contrast (Lu *et al.*, 2015). Most existing literature on image contrast focuses on image enhancement techniques for digital images, electronic displays, or printers (e.g., Fidler *et al.*, 2007; Morrow *et al.*, 1992; Ortiz-Jaramillo *et al.*, 2018; Panetta *et al.*, 2013; Shiao *et al.*, 2007). However, one study in which subjects rated the pleasantness of printed image reproductions found that photographs with enhanced image contrast were rated as more pleasing (Pedersen *et al.*, 2010). Also, higher contrast reproductions are better liked than the original paintings (Dijkstra and van Dongen, 2017; van Dongen and Zijlmans, 2017). Similarly, liking of photographs decreased as image contrast was reduced (Tinio *et al.*, 2011). In marketing, high-contrast package designs were perceived as more exciting, competent and sincere than low-contrast designs (Orth and Malkewitz, 2012). In the online environment, contrast in mobile online shopping environments decreased spatial crowding perceptions and perceived time and effort costs, and increased satisfaction (Sohn *et al.*, 2017). To the best of our knowledge, no investigations of image contrast's effects on consumer liking of brand-generated social media content have been conducted. Yet, aforementioned evidence from other contexts leads to the critical inference that greater image contrast will improve consumer liking of marketing content on image-centric social media platforms. Formally,

H2: High-contrast social media images will elicit greater liking than low-contrast social media images.

It is worth noting that higher contrast does not always enhance liking. For example, liking did not differ across advertisements with high versus low figure-ground contrast (Kim and Lakshmanan, 2015). This suggests the existence of the underlying mechanisms that must be investigated. Yet, the mechanisms driving the influence of structural properties (symmetry and image contrast) on consumers and the extent of these effects on consumer response remain uninvestigated empirically. We propose that these effects may be explained from a synthesis combining perspectives on *processing fluency* with perspectives on *aesthetic response*. Both are discussed below.

Processing Fluency and Aesthetic Response

Competing mechanisms have been proposed to account for symmetry and image contrast's effects on liking. The current research synthesizes the metacognitive perspective of ease of processing and insights from experimental aesthetics/neuroaesthetics to explain structural properties' effects via processing fluency and aesthetic responses.

Processing fluency is defined as the subjective experience of ease with which a stimulus (e.g., a social media image) is processed (Alter and Oppenheimer, 2009; Reber *et al.*, 2004b; Schwarz, 2018) or the subjective ease of mental operations (Brinol *et al.*, 2006; Reber *et al.*, 2004a). Whenever consumers are presented with textual or graphic information, its processing generates a corresponding experience that ranges from fluent to disfluent. This experience, in turn, influences consumers' downstream responses (Bian and Wang, 2015; Gomez *et al.*, 2017; Seo and Scammon, 2017; Sunaga *et al.*, 2016). Experimental manipulations that successfully increase processing fluency of an image are diverse (Alter and Oppenheimer, 2009). For instance, conceptually-related priming (e.g., showing the word "lock" or "key" before an image

of a lock) increased processing fluency of the pictures that followed (Winkielman *et al.*, 2003). In addition to priming, and relevant to current research, structural properties of an image also influence processing fluency and, consequently, downstream responses.

Several researchers have argued that the structural property of symmetry should facilitate fluent processing (Reber *et al.*, 2004a; Schwarz, 2018; Winkielman *et al.*, 2003). Importantly, visual perception of mirror symmetry is rapid and effortless (Pecchinenda *et al.*, 2014; Wagemans, 1995), in line with the heuristic processing of which processing fluency is a part. Yet, empirical studies linking image symmetry to processing fluency are scarce, despite theoretical conceptualizations. Additionally, some findings contradict the direct symmetry-processing fluency relationship. For example, less symmetrical product designs heightened ease-of-use perceptions (Creusen *et al.*, 2010), and asymmetrical logos enhanced arousal and brand evaluations (Luffarelli *et al.*, 2018). Thus, further investigation is necessary.

Like symmetry, image contrast should be another structural property that influences an image's processing fluency. Unfortunately, most conceptual work positing enhanced processing fluency (Brinol *et al.*, 2006; Reber *et al.*, 2004a; Zucker *et al.*, 1983) and empirical studies of effects on processing fluency have examined figure-ground contrast (e.g., Reber *et al.*, 1998; Reber *et al.*, 2004b), as opposed to image contrast, with only a few exceptions (e.g., Tinio *et al.*, 2011). These empirical studies found that higher versus lower figure-ground contrast improved consumer ability to distinguish moving objects (Kim and Lakshmanan, 2015), lessened reaction times for rectangular bars against a solid background (Broggin *et al.*, 2012), and increased ratings of processing fluency and speed of detection and aided identification with fewer errors for words against a white background (Reber *et al.*, 2004b). Yet, these studies of figure-ground contrast often did not assess participants' subjective processing fluency directly (Reber *et al.*,

1998), or did not assess it at all (Brinol *et al.*, 2006; Willems and van der Linden, 2006). Moreover, the direct contrast-processing fluency relationship observed with simple figure-ground contrast stimuli has sometimes been contradicted in research on more complex images, such as online shopping images and monochrome photographs (e.g., Maier and Dost, 2018; Tinio *et al.*, 2011). Thus, further empirical investigations are necessary with direct assessment of processing fluency to determine if higher contrast does, in fact, enhance processing fluency when consumers encounter more complex photographic images.

However, we draw a critical inference that image contrast should create the enhanced processing fluency that others have conceptualized for figure-ground contrast (Reber *et al.*, 2004a). The identification of objects in our environment is a key function of our perceptual system, and greater image contrast should aid this process. Implying support, greater contrast has been shown to ease visual processing by improving stimulus detection and identification, easing discrimination or distinctions between stimuli, accentuating textures, enhancing visual information in shadow areas, and visually isolating elements (Cambridge in Colour, 2020; Kim and Lakshmanan, 2015; Pedersen *et al.*, 2010; Simone, 2016).

Some researchers have proposed a direct link between processing fluency of a stimulus and consequent liking (Belke *et al.*, 2010; Maier and Dost, 2018; McShane *et al.*, 2019). Other literature suggests that processing fluency might first influence beauty judgments (Labroo and Pocheptsova, 2016; Reber *et al.*, 2004a; Schwarz, 2018), which, in turn, may impact liking of the fluently processed stimulus. This assertion can be linked to the research in experimental aesthetics, neuroaesthetics, marketing and psychology that investigated the influence of structural properties on *aesthetic response* to images (e.g., Berlyne, 1974; Orth and Malkewitz, 2012; Redies *et al.*, 2020). According to theoretical work in experimental aesthetics, any image

conveys both semantic (i.e., meaning) information as well as aesthetic information that arises through its structural properties. Favorable aesthetic responses should arise if structural properties are judged to be beautiful or arouse aesthetic appreciation regardless of the semantic meaning communicated by an image (Berlyne, 1974). Structural properties influence an audience within 100-200 milliseconds after initial exposure (Redies *et al.*, 2020). In the current research context, aesthetic responses are judgements of aesthetic appreciation or the beauty of social media images.

Prior research has linked both symmetry and contrast to aesthetic response. People appear to have more favorable aesthetic responses toward symmetric than non-symmetrical images, whether they depict human faces (Baudouin and Tiberghien, 2004), representational paintings (Sidhu *et al.*, 2018) or abstract patterns (Bode *et al.*, 2017; Tinio and Leder, 2009). Conceptual work in psychology suggests an explanation. Researchers proposed that responses to symmetry are attributable to processing fluency, which explains symmetry's effect on perceiver's aesthetic response and liking (Reber *et al.*, 2004a; Schwarz, 2018). Further, image contrast should also influence aesthetic response through its effect on processing fluency, as has been theorized for figure-ground contrast (Reber *et al.*, 2004a). Some empirical studies of figure-ground contrast support this theorized relationship. For example, higher versus lower figure-ground contrast increased ratings of prettiness but lessened ratings of ugliness for circles against backgrounds (Reber *et al.*, 1998) and increased favorable aesthetic responses toward monochrome logos against a white background (Zhang *et al.*, 2017).

Finally, greater aesthetic responses should lead to increased liking. Theory-building in neuroaesthetics and experimental aesthetics predicts that the positive aesthetic responses associated with higher contrast stimuli should increase liking (Berlyne, 1974; Skov and Nadal,

2020); empirical work supports this relationship between aesthetic responses and liking (Marin *et al.*, 2016; van Dongen and Zijlmans, 2017; Zarzosa and Huhmann, 2019).

Therefore, based on the prior conceptualizations from the fields of neuroaesthetics, experimental aesthetics and cognitive psychology, we extend prior research by combining theoretical relationships from these domains into a process hypothesis with processing fluency and aesthetic response as serial mediators that link symmetry and image contrast → to processing fluency → aesthetic response → liking. Formally,

H3: Consumer liking of social media posts increases when images are symmetrical because their processing fluency produces more favorable aesthetic responses.

H4: Consumer liking of social media posts increases with greater image contrast because the resultant processing fluency produces more favorable aesthetic responses.

The existing social media marketing literature has studied symmetry, contrast, processing fluency and aesthetic response either in isolation or in pairs (see summary of research in Table 2). However, to the best of our knowledge, the relationship between image structural properties (such as symmetry and contrast) and consumer liking via a serial mediation process including processing fluency and aesthetic response has not been previously tested empirically.

<<Insert Table 2 about here>>

The full theoretical framework is presented in Figure 1. Two studies test the hypotheses within a social media marketing context. The experimental lab study presented next will investigate

symmetry and image contrast direct effects on consumer liking (H1a, H1b, H2), and the explanatory mechanisms for these observed effects (H3, H4). Next, we present a field study that employs content analysis of brand-generated social media images to investigate marketplace manifestations of the theorized direct effects. This combination of experimental and field studies ensures the internal and external validity of the findings.

<<Insert Figure 1 about here>>

Experimental Study¹

An experiment was designed and conducted to investigate the effect of the structural properties of symmetry and image contrast on liking, as well as to investigate the serial mediation of processing fluency and aesthetic response as a possible explanation of this effect.

Sample, Procedure, and Experimental Design

Experimental Stimuli

. Imagery stimuli were developed for two vacation destinations – the beach and Washington DC – by an independent contractor using professional graphical software. The independent contractor first reviewed typical images posted on social media by several hospitality brands. The travel and tourism industry has been strongly affected by social media, due to its intangible, highly experiential nature. For many brands in this industry, digital touchpoints became primary (if not only) sources of contact with potential customers (Xiang *et*

¹ The experimental study was conducted in Spring 2017. The field study was conducted in Fall 2016 and Spring 2017. The studies are presented in reverse chronological order to improve the flow of the manuscript.

al., 2015). Thus, travel and tourism brands can provide rich, managerially relevant material for social media research. The images produced by the independent contractor were within this selected context of the travel and tourism industry and highly similar to content posted by hospitality brands on their social media pages. To avoid the contaminating influence of prior brand experience or reactions to the branding elements and the reduced realism of a mock travel brand, these images included no brand-related identifiers. To ensure internal validity, all images were the same size (600 x 600 pixels). Other experimental research on image characteristics also hold size constant; for example, Tinio *et al.* (2011) sized all images in their experiments to 800 x 600 pixels.

Due to the nature of depicted objects, the Washington DC image could feature horizontal symmetry, whereas the beach destination image could feature vertical symmetry. For the symmetry manipulation, a vertically symmetrical image of two beach huts was altered to eliminate the symmetry around the vertical axis, and a horizontally symmetrical image of the US Capitol reflected in pool was altered to eliminate the mirror reflection around the horizontal axis (Figure 2 presents these four images). For the contrast manipulation, the independent contractor altered the original high-contrast images in Figure 2 by reducing their global image contrast to 50% using Microsoft Photos software.

<<Insert Figure 2 about here>>

Pretest

Symmetry and contrast perceptions for these images were first pretested on a sample of 116 Amazon mTurk users to ensure the success of image manipulations. High-contrast images were perceived as having higher contrast ($M = 5.35$, $SD = 1.60$) than low-contrast images ($M =$

3.71, $SD = 1.87$; $t = -5.07$; $p < .001$), and symmetrical images were perceived as having greater symmetry ($M = 5.13$, $SD = 1.28$) than non-symmetrical images ($M = 4.08$, $SD = 1.94$; $t = -3.39$; $p = .001$). Also, as expected based on information about global image contrast and file size (Cambridge in Colour, 2020), high-contrast images resulted in a larger file size than low-contrast images (309 KB vs. 161 KB for the beach image, 274 KB vs. 131 KB for the Washington DC image).

Main Study

For the main study, 361 participants (55% women, $M_{\text{age}} = 24.3$, $SD_{\text{age}} = 6.5$) were recruited from a large Southwestern U.S. university. The students were recruited in large undergraduate classes in exchange for an extra-credit.

Participants viewed full-color experimental stimuli on a laptop computer screen following instructions to imagine that they had come across the image while browsing social media. Participants were randomly assigned to one condition of a 2 (image contrast: high/low) x 2 (symmetry: absent/present) experimental design. Image contrast and symmetry presence were manipulated between subjects. Each subject was exposed to two images, one of each travel destination, to minimize noise resulting from different individual preferences for tourist destinations. Presentation order (beach vacation image first vs. Washington DC vacation image first) was randomized between subjects.

After exposure to each stimulus, participants completed a brief questionnaire. A three-item scale measured liking with seven-point semantic differential items anchored by “bad/good”, “dislikeable/likeable”, and “unfavorable/favorable” (Huhmann and Albinsson, 2012). Consumers’ aesthetic response was measured via a six-item scale with seven-point semantic

differential items anchored by “displeasing/pleasing”, “unattractive/attractive”, “beautiful/ugly”, “nice-looking/poor-looking”, “enjoyable/offensive”, and “good/bad appearance” (Bell *et al.*, 1991). Next, processing fluency was measured using a single seven-point Likert-type scale item “Difficult to process” with endpoints of “strongly agree” and “strongly disagree” (Kostyk *et al.*, 2017; Song and Schwarz, 2008; Graf *et al.*, 2017). The end of the survey queried participants’ general familiarity with social media, and demographic information, but these variables had no significant effect and are not included in the following analysis.

Data Analysis and Results

First, three-way multivariate analysis of variance (MANOVA) was conducted with image orientation (vertical or horizontal) as within-subjects, and symmetry and contrast as between-subjects grouping variables. Dependent variables were processing fluency, aesthetic response, and liking. Multivariate analysis suggested no interaction effect between image orientation, presence of symmetry, and level of image contrast on the combined dependent variables ($F(3, 343) = 0.18, p = .910$; Wilks' $\Lambda = .99$). Further analyses examine the between-subjects two-way MANOVAs for each type of symmetry separately.

Vertical Symmetry and Contrast

The two-way MANOVA for the vertical orientation image included symmetry and contrast as between-subjects grouping variables, and processing fluency, aesthetic response, and liking as dependent variables. Multivariate analysis suggested no interaction effect between presence of symmetry and level of image contrast on the combined dependent variables ($F(3, 355) = 2.14, p = .095$; Wilks' $\Lambda = .98$, partial Eta squared = .018). Main effects of both symmetry ($F(3, 355) =$

3.33, $p = .02$; Wilks' $\Lambda = .97$, partial Eta squared = .027) and contrast ($F(3, 355) = 4.67$, $p = .003$; Wilks' $\Lambda = .96$, partial Eta squared = .038) on the combined dependent variables were significant.

In support of H1a, liking was greater for symmetrical than non-symmetrical images ($M=6.5$ vs. $M=6.1$, $F(1,359)=7.9$, $p<.01$). Also, processing fluency was greater for symmetrical than non-symmetrical images ($M = 6.6$ vs. $M = 6.2$, $F(1,359) = 6.5$, $p < .05$) and aesthetic response was more favorable for symmetrical than non-symmetrical images ($M = 6.4$ vs. $M = 6.0$, $F(1,359) = 4.6$, $p < .05$).

In support of H2, liking was greater with high-contrast than low-contrast for the vertically-oriented images ($M = 6.5$ vs. $M = 6.1$, $F(1,359) = 10.6$, $p = .001$). Additionally, processing fluency was greater with high-contrast than low-contrast images ($M = 6.5$ vs. $M = 6.2$, $F(1,359) = 3.3$, $p = .06$). High-contrast images also elicited more favorable aesthetic responses than low-contrast images ($M = 6.5$ vs. $M = 5.9$, $F(1,359) = 13.6$, $p < .001$).

Once the relationships between the structural variables of symmetry or contrast and liking in H1a and H2 was established, the possible serial mediation by processing fluency and aesthetic response was investigated.

Vertical Symmetry Mediation Analysis

Mediation was assessed using PROCESS for SPSS (Hayes, 2017), using serial mediation Model 6 (Hayes, 2017). H3 predicted that liking increases when images are symmetrical because their processing fluency produces more favorable aesthetic responses. In support of H3, a serial mediation model with (1) processing fluency and (2) aesthetic response as mediators demonstrated *indirect-only* mediation as the significant direct effect of symmetry on liking

became non-significant once the mediators were included ($p = .07$; Zhao *et al.*, 2010). Here and for all further analyses, the significance of the indirect effect was assessed using a bootstrapping procedure that computed 5,000 samples of indirect effects at the 5th and 95th percentiles. Serial mediation path observed in this model was:

Symmetry \rightarrow Processing fluency \rightarrow Aesthetic response \rightarrow Liking ($\beta = 0.18$, $SE = .08$, 95% CI [.05, .38]). Thus, by conventional standards (Hayes, 2017), processing fluency and aesthetic response serially mediated the effect of symmetry presence on liking.

Contrast Mediation Analysis for Vertically Oriented Images

In support of H4, a serial mediation model with (1) processing fluency and (2) aesthetic response as mediators demonstrated *indirect-only* mediation as the significant direct effect of contrast on liking became non-significant once the mediators were included ($p = .89$). Serial mediation path observed in this model was:

Contrast \rightarrow Processing fluency \rightarrow Aesthetic response \rightarrow Liking ($\beta = 0.13$, $SE = .08$, 95% CI [.002, .31]). Thus, by conventional standards (Hayes, 2017), processing fluency and aesthetic response serially mediated the effect of high image contrast on liking.

Horizontal Symmetry and Contrast

The two-way MANOVA for the horizontal orientation image included symmetry and contrast as between-subjects grouping variables, and aesthetic response, liking and processing fluency as dependent variables. Multivariate analysis suggested an interaction effect between presence of symmetry and level of image contrast on the combined dependent variables ($F(3, 355) = 2.81$, $p = .03$; Wilks' $\Lambda = .98$, partial Eta squared = .023).

Because the interaction supersedes the main effects (see Table 2), planned contrasts were performed to test the hypotheses. Under both low contrast ($F(3, 177) = 3.07, p < .05$; Wilks' $\Lambda = .95$) and high contrast ($F(3, 176) = 5.26, p < .01$; Wilks' $\Lambda = .92$), symmetry influenced the combined dependent variables. In support of H1b, presence of symmetry resulted in greater liking under both low-contrast ($M = 5.9$ vs. $M = 5.3, F(1,179) = 5.9, p < .05$) and high-contrast conditions ($M = 6.5$ vs. $M = 5.9, F(1,178) = 14.9, p < .001$). Symmetry did not impact processing fluency under the high-contrast condition ($F < 1$), but increased processing fluency under the low-contrast condition ($M = 6.2$ vs. $M = 5.6, F(1,179) = 7.0, p < .01$). Finally, presence of symmetry elicited more favorable aesthetic responses under both low-contrast ($M = 5.8$ vs. $M = 5.2, F(1,179) = 7.4, p < .01$) and high-contrast conditions ($M = 6.3$ vs. $M = 5.9, F(1,178) = 6.4, p < .05$).

Further, whether symmetry was present ($F(3, 172) = 6.26, p < .001$; Wilks' $\Lambda = .90$) or absent ($F(3, 181) = 4.50, p < .01$; Wilks' $\Lambda = .93$), contrast affected the combined dependent variables. In support of H2, high contrast resulted in greater liking than low contrast whether symmetry was present ($M = 6.5$ vs. $M = 5.9, F(1,174) = 17.2, p < .001$) or absent ($M = 5.9$ vs. $M = 5.3, F(1,183) = 8.9, p < .01$). Higher contrast did not impact processing fluency when symmetry was present ($F < 1$), but increased processing fluency when symmetry was absent ($M = 6.4$ vs. $M = 5.6, F(1,183) = 10.0, p < .01$). Finally, higher contrast elicited more favorable aesthetic responses when symmetry was present ($M = 6.3$ vs. $M = 5.8, F(1,174) = 8.2, p < .01$) or absent ($M = 5.9$ vs. $M = 5.2, F(1,183) = 11.4, p < .01$). Next, possible mediating roles of processing fluency and aesthetic response in the relationships between the structural variables of symmetry or contrast and liking were investigated.

Horizontal Symmetry Mediation Analysis

In support of H3, a serial mediation model with (1) processing fluency and (2) aesthetic response as mediators demonstrated *indirect-only* mediation as the significant direct effect of symmetry on liking became non-significant once the mediators were included ($p = .11$). Serial mediation path observed in this model was:

Symmetry \rightarrow Processing fluency \rightarrow Aesthetic response \rightarrow Liking ($\beta = 0.12$, $SE = .07$, 95% CI [.01, .29]). Thus, by conventional standards (Hayes, 2017), processing fluency and aesthetic response serially mediated the effect of symmetry presence on liking.

Contrast Mediation Analysis for Horizontally Oriented Images

In support of H4, a serial mediation model with (1) processing fluency and (2) aesthetic response as mediators demonstrated *indirect-only* mediation as the significant direct effect of contrast on liking became non-significant once the mediators were included ($p = .11$). Serial mediation path observed in this model was:

Contrast \rightarrow Processing fluency \rightarrow Aesthetic response \rightarrow Liking ($\beta = 0.17$, $SE = .08$, 95% CI [.05, .36]). Thus, by conventional standards (Hayes, 2017), processing fluency and aesthetic response serially mediated the effect of high image contrast on liking.

Discussion

This controlled experiment investigated the effects of a social media marketing image's structural properties (symmetry and contrast) on consumer liking. This study also tested a possible causal chain to explain the relationship between an image's structural properties and

liking – the influence of processing fluency on aesthetic response. Results are summarized in Table 3.

<<Insert Table 3 around here>>

Symmetry and higher contrast improved processing fluency, aesthetic responses, and liking in both images with a vertical or a horizontal axis of symmetry. Further, symmetry and contrast interact such that processing fluency achieves a ceiling effect whenever symmetry is present, or image contrast is high. Processing fluency is reduced when neither symmetry nor high contrast appears. Thus, practitioners may enhance processing fluency by incorporating either symmetry or high contrast into their images.

In terms of underlying processes, processing fluency and aesthetic response appear to explain the relationship between an image's structural properties of symmetry and contrast and liking. Serial mediation including both (1) processing fluency and (2) aesthetic response was shown for both types of symmetry and image contrast.

Prior research has found salience to be greater for vertical than horizontal symmetry (Bode *et al.*, 2017; Pecchinenda *et al.*, 2014; Wagemans, 1997) and recall to be stronger with vertical than horizontal symmetry over asymmetrical images (Rossi-Arnaud *et al.*, 2012). Further, Rossi-Arnaud *et al.* (2012) also found horizontal symmetry to be more susceptible to interference than vertical symmetry. Similarly, the current study indicates that low image contrast may interfere, but not completely attenuate horizontal symmetry's effect on consumer liking. Thus, the two symmetry types do not necessarily share the same effect on consumers nor are effects generalizable across structural properties. Instead, structural properties appear to have

idiosyncratic effects on consumer responses, which suggests that practitioners considering the incorporation of symmetry into the social media images should opt, when possible, for vertical rather than horizontal symmetry, and use only high-contrast images in conjunction with any symmetry.

Further insights arise by examining the magnitude of effects expressed by the standardized paths in the serial mediation model. Vertical symmetry's effect on consumer liking via processing fluency and aesthetic response is larger than that of the image contrast; however, contrast outperforms horizontal symmetry. Thus, marketers seeking to increase liking on social media via processing fluency and aesthetic response to their posts should first consider vertical symmetry, followed by the image contrast, followed by horizontal symmetry.

Field Study of Brand Instagram Accounts

This study tests the effects of structural properties of brand-generated social media images on consumer "liking" in a real marketplace environment. The presence of symmetry and degree of image contrast were recorded in a content analysis, and then related to the "likes" and comments received by each image on one image-centric social media platform, Instagram.

Consumer Engagement via "Likes" and Comments

Consumer liking of brand-generated social media posts is closely related to the concept of consumer engagement with these posts. Consistent with prior social media literature, *consumer engagement* is defined here as social media users' behavioral response to a post which may include elaborating on the post through comments; associating with the post by reposting or sharing it; or expressing pleasure, support, or approval through clicking a "like" button. Thus,

engagement is broader as it includes “likes”, as well as other behavioral responses, such as the comments or shares that such posts receive (Barger *et al.*, 2016; Kabadayi and Price, 2014; McShane *et al.*, 2019).

Engagement with both brand-generated and user-generated social media content has been a focus of much recent research (Barger *et al.*, 2016; De Vries *et al.*, 2012; Ji *et al.*, 2019; Kabadayi and Price, 2014; McShane *et al.*, 2019; Valentini *et al.*, 2018). Marketers perceive engagement with social media messages to be an important strategic metric (Chahine and Malhotra, 2018; Kabadayi and Price, 2014). Engagement with brand-generated social media content leads to product- and brand-related consequences, such as positive word-of-mouth, purchase behavior, and customer loyalty (Barger *et al.*, 2016; De Vries *et al.*, 2012; Verma *et al.*, 2012). “Likes” also impacts consumer behavior beyond the online context (Mochon *et al.*, 2017). For example, for non-profit organizations, “likes” translate into donation behavior (Wallace *et al.*, 2017).

Various factors that influence engagement and/or “likes” have been investigated, including brand-related factors, such as prior attitude towards the brand and brand image (Bernritter *et al.*, 2016; Huang *et al.*, 2013); consumer-related factors, such as individual differences, social influence, entertainment-, or reward-seeking (Azar *et al.*, 2016; Kabadayi and Price, 2014; VanMeter *et al.*, 2015; Wallace *et al.*, 2012); and content-related factors, such as message content (Ashley and Tuten, 2015; McShane *et al.*, 2019) or format (Barger *et al.*, 2016), emotional (Swani *et al.*, 2013) or scarcity appeals (Koch and Benlian, 2015), parts of speech in textual posts (Cruz *et al.*, 2017; Noguti, 2016), and interactive features (De Vries *et al.*, 2012). However, image-related factors remain under-researched.

On social media platforms predominated by visual content (e.g., Instagram, Tumblr, Pinterest, and Snapchat), consumers may experience processing fluency and an aesthetic response from viewing some images, which should encourage behavioral expressions of consumer engagement (e.g., comments to affiliate the image with the consumer and “likes” to indicate approval, preference, or enjoyment). Prior findings indicate that images outperform text in generating consumer engagement with social media posts (Kim *et al.*, 2015; McShane *et al.*, 2019) and that the image-related factor of greater image vividness generates more “likes” and comments (De Vries *et al.*, 2012). Yet, as shown in Table 2, no prior studies were uncovered that investigated the symmetry or contrast within, processing fluency of, or aesthetic responses to social media images, and their effects on consumer engagement.

Symmetry and image contrast represent two structural properties that might shape consumer engagement with social media marketing messages. Symmetry in logos has been shown to positively impact brand recognition (Henderson and Cote, 1998). A similar effect was detected for images with high vs. low figure-ground contrast, which lead to faster recognition (Checkosky and Whitlock, 1973; Reber *et al.*, 1998). In both cases, recognition can be inferred to be a downstream effect of consumer engagement. Most importantly, prior research found a strong relationship between consumer liking and “likes” on social media (Halaszovich and Nel, 2017). If presence of symmetry and high image contrast encourage consumer liking (via processing fluency and aesthetic response) and engagement (i.e., “likes” or comments) is a behavioral manifestation closely related to consumer liking, then on an image-centric social media platform (e.g., Instagram):

H5a: Brand-generated images with vertical symmetry will elicit more consumer engagement than non-symmetrical images.

H5b: Brand-generated images with horizontal symmetry will elicit more consumer engagement than non-symmetrical images.

H6: High-contrast images will elicit more consumer engagement than low-contrast images.

Sampling Procedures

Field data was collected by analyzing the content of brand Instagram posts. Instagram was selected as an image-centric social media platform where images remain accessible to users. Compared to Facebook or Twitter, Instagram features primarily image posts, and compared to Snapchat, these images can be repeatedly revisited by the users, even after closing the browser or the app (Yurieff, 2017).

All brands sampled for the present analysis belonged to the same industry (hotel chains), which ensured data comparability, as well as consistency with the laboratory experiment. As a first step in the sampling process, a list of worldwide hotel brands was ranked by size with the total number of rooms serving as a main criterion. Next, a search for an active Instagram account was performed for each of the top brands from the list. Top brands with active Instagram accounts were: Hilton, Marriott, Hyatt, Fairmont, Mandarin Oriental, Four Seasons, Omni, Shangri-La, and Taj. A systematic random sampling procedure was then employed to generate a sub-sample of the Instagram posts for each brand. The first post was picked from the most recent ten using a random number generator, and then a sample was collected by iteratively choosing every third post. As there were no reasons to suspect periodicity in this population, systematic random sampling is expected to be as precise, or more precise, than simple random sampling

(Stehman, 1992). Videos, text and non-square images were excluded from the sample to ensure comparability of image type and size, in line with prior research on images' structural properties (Tinio *et al.*, 2011). Following this sampling procedure, the number of posts for each hotel brand ranged from 60 to 71 for a total sample size of 610 Instagram posts.

Consumer Engagement and Brand Coding

Following past practice in social media studies (Barger *et al.*, 2016; Ji *et al.*, 2019; Valentini *et al.*, 2018), *consumer engagement* was operationalized as users' elaboration on, association with, or approval through the number of comments and "likes" that consumers added to each social media post. Additionally, the hotel chain brand associated with each image was recorded as a categorical control variable to account for heterogeneity across brands in the regression model.

Symmetry Coding

Coders were provided definitions of vertical ("involving reflection around a vertical axis") and horizontal ("involving reflection around a horizontal axis") *symmetry* consistent with prior literature (Creusen *et al.*, 2010; Reber *et al.*, 2004a; Treder, 2010; Wagemans, 1995, 1997). Upon observing such a reflection around an imaginary axis, coders recorded that type of symmetry as present (1). Otherwise, coders recorded it as absent (0). Consequently, an image could have both, vertical only, horizontal only, or no symmetry.

Pretest

Following existing guidelines for content analysis in consumer research, a pretest of the symmetry coding sheet and definitions was conducted to determine if coders could achieve

acceptable interrater reliability in the main content analysis or if definitions and instructions must first be improved. Pretests of content analysis methods typically require a minimal number of judges (i.e., two) to calculate interrater agreement (Kassarjian, 1977; Rust and Cooil, 1994). This initial pretest was performed by two graduate students. The coders achieved over 85% or greater agreement for all variables (Kassarjian, 1977), which resulted in Proportional Reduction of Loss (PRL) statistic of 84% or higher (Rust and Cooil, 1994). Hence, the coding definitions, instructions, and recruitment of two coders was deemed sufficient for coding symmetry in the field study to ensure acceptable levels of reliability (Nunnally, 1978; Rust and Cooil, 1994).

Field Study Coding

Two independent coders were recruited for the main study. The coders (one male and one female) were senior undergraduate students, and chosen because Millennials are considered a key target audience for brand posts on Instagram (Pew Research Center, 2015). Each coder recorded whether vertical and/or horizontal symmetry was present in 399 full-color images taken from the Instagram posts.

High agreement (above 83%) was evident in the overlapping 31% of images coded by both coders. Employing Rust and Cooil's (1994) reliability statistic as a more rigorous test of interrater reliability, PRL indices (81% to 99%) were deemed acceptable (Nunnally, 1978; Rust and Cooil, 1994). Coders resolved any disagreements through discussion.

To ensure that the independent coders remained blind to the research hypotheses, a third coder (a graduate student in marketing) separately recorded the hotel brand name and the number of "likes" and comments received by each post in the sample. The other two coders were unaware of this separate coding and, thus, their assessment of each images' vertical and

horizontal symmetry was uninfluenced by the number of “likes” and comments received by each post.

Image Contrast Measures

Image contrast has been measured in many ways with no agreement on the best measure. Despite the development of various complex statistical measures, the most used measures remain simpler ones (Ortiz-Jaramillo *et al.*, 2018; Panetta *et al.*, 2013; Pedersen *et al.*, 2010; Simone, 2016). To aid social media marketing practitioners and future researchers interested in extending our findings, we also used measures of contrast that would be relatively simple to calculate.

File size. Size of JPEG files is an easy-to-use measure as digital images posted on social media images can easily be converted to JPEG files of equivalent height and width. Greater variation in luminosity within an image increases file size when creating a JPEG file as all grayscale values in the image are transformed into coefficients. Because of its compression algorithm, JPEG file size correlates with contrast and is a good proxy measure (Cambridge in Colour, 2020; Fidler *et al.*, 2007; Marziliano *et al.*, 2004; Shiao *et al.*, 2007).

Thus, coders recorded file size in kilobytes to a precision of two decimal places on the coding sheet during the field study. Other factors that might contribute to JPEG file size differences, such as image dimensions or color palette (grayscale, 8-bit color, 24-bit color, etc.) were carefully controlled for this sample. Specifically, all Instagram posts in the sample were saved as 8-bit color 600 x 600-pixel images. Thus, higher image contrast resulted in a larger file size. For instance, consider the images depicted in Figure 3. For each image pair, the high-contrast (+40% global contrast) version resulted in a larger file size than the low-contrast (-40% global contrast) version of the same image.

<<Insert Figure 3 around here>>

Physical contrast. Additionally, we supplemented the file-size measure with a physical contrast measure (King-Smith and Kulikowski, 1975; Swanson *et al.*, 1984), in which image contrast (C) is a function of peak luminance (L_{pk}) and average luminance (L_0) of the image:

$$C = (L_{pk} - L_0) / L_0$$

King-Smith and Kulikowski's (1975) measure is one of several similar physical or objective measures developed in the 1970s and 1980s to quantify contrast in complex images that have been applied to digital photography and digital image display contexts (Simone, 2016). Peak luminance and average luminance information are readily available from histograms of the luminosity or brightness intensity on professional digital cameras, image editing software (e.g., *Photoshop*), and the scientific image-processing program *ImageJ* (Schneider *et al.*, 2012). The advantage of histogram-based physical measures is that the much greater consistency across applications than statistical measures or local contrast measures (Morrow *et al.*, 1992; Panetta *et al.*, 2013) and their high correlation with viewers' perceptions of image contrast (Ortiz-Jaramillo *et al.*, 2018; Pedersen *et al.*, 2010). Therefore, to supplement image contrast analysis via image file size, the research team generated luminosity histograms for each of the images in the sample using *ImageJ* software, and computed the physical contrast measure using King-Smith and Kulikowski's (1975) formula.

Analysis of the Field Data

Out of the 610 brand Instagram posts analyzed, 32% used at least one type of symmetry. Only 2% included both. Vertical symmetry appeared most often (153 posts). While all brands used symmetry in some Instagram posts, frequency of symmetry use differed across brands ($\chi^2 = 37.6$, $df = 8$, $p < .01$; $\Phi = 0.25$, $p < .01$) (see Table 4). The proportion of posts featuring image symmetry ranged from 50% of all posts for the Hilton brand to 12.7% of all posts for the Omni hotel brand.

<<Insert Table 4 around here>>

File size ranged from 27.2 KB to 151 KB ($M = 79.9$, $SD = 24.1$). A median split was performed on this continuous variable to divide all posts into two groups on the file size measure: high-contrast posts and low-contrast posts. While all brands posted both low- and high-contrast images on their brand's Instagram account, the frequency of high-contrast posts differed across brands ($\chi^2 = 29.13$, $df = 8$, $p < .001$; $\Phi = 0.22$, $p < .001$; see Table 5). The proportion of high-contrast images ranged from 71.4% of all posts for the Four Seasons brand to 30.9% of all posts for the Taj hotel brand.

<<Insert Table 5 around here>>

Outcome variables in the field study were examined following practices common in prior social media research (Cruz *et al.*, 2017; De Vries *et al.*, 2012; McShane *et al.*, 2019). These analyses examined the number of “likes” and comments separately, as well as a consumer engagement metric (computed as a sum of the number “likes” and the number of comments). For each of these outcome variables, the skewed distribution of the number of comments and “likes” received by social media posts was normalized to reduce the effect of outliers through a natural logarithm transformation as follows:

$$\text{Likes} = \ln(\text{Number of “likes”})$$

Comments = \ln (Number of comments)

Consumer engagement = \ln (Number of likes + Number of comments)

Multiple regression analysis established the joint effects of vertical symmetry presence, horizontal symmetry presence, and image contrast on consumer engagement. The model also included the brand name as a dummy control variable to account for differences in each hotel brand's Instagram follower base as well as the type and content of brand-related posts.

Regression results indicated that the predictors (i.e., vertical symmetry, horizontal symmetry, contrast operationalized as file size, and brand as a control) explained 21% of the variance ($R^2 = .210$, $F(4,609) = 40.25$, $p < .001$). In support of H5a and H5b, the presence of vertical ($\beta = .15$, $p < .001$) and horizontal ($\beta = .17$, $p < .001$) symmetry predicted consumer engagement. In support of H6, image contrast also predicted consumer engagement ($\beta = .26$, $p < .001$).

Although not hypothesized, regression analysis assessed the effects of symmetry and contrast on "likes" and comments separately. The presence of vertical ($\beta = .15$, $p < .001$) and horizontal ($\beta = .17$, $p < .001$) symmetry, as well as image contrast ($\beta = .26$, $p < .001$) successfully predicted the number of "likes" ($R^2 = .210$, $F(4,609) = 39.33$, $p < .001$). Similarly, the presence of vertical ($\beta = .14$, $p < .001$) and horizontal ($\beta = .15$, $p < .001$) symmetry, as well as image contrast ($\beta = .27$, $p < .001$) predicted the number of comments ($R^2 = .211$, $F(4,609) = 40.54$, $p < .001$).

The hypotheses were similarly supported when using the physical contrast measure instead of the file size. Regression results indicated that the predictors (i.e., vertical symmetry, horizontal symmetry, contrast operationalized using King-Smith and Kulikowski's (1975)

physical measure, and brand as a control) explained 15% of the variance ($R^2 = .150$, $F(4,609) = 26.25$, $p < .001$). In support of H5a and H5b, the presence of vertical ($\beta = .16$, $p < .001$) and horizontal ($\beta = .15$, $p < .001$) symmetry predicted consumer engagement. In directional support of H6, image contrast also predicted consumer engagement ($\beta = .06$, $p = .1$). In other words, the smaller the difference between the peak and average luminosity in the intensity histogram, which indicates lower physical contrast, the lower the consumer engagement. Similar to the analysis with file size as the measure of contrast, regression analysis assessed the effects of symmetry and contrast on “likes” and comments. The presence of vertical ($\beta = .16$, $p < .001$) and horizontal ($\beta = .14$, $p < .001$) symmetry successfully predicted the number of “likes”. Image contrast also predicted the number of likes ($\beta = .06$, $p = .1$), albeit only directionally ($R^2 = .150$, $F(4,609) = 25.72$, $p < .001$). Next, regression analysis assessed the effects of symmetry and contrast on comments ($R^2 = .150$, $F(4,609) = 26.07$, $p < .001$). The presence of vertical ($\beta = .16$, $p < .001$) and horizontal ($\beta = .12$, $p < .001$) symmetry, as well as image contrast ($\beta = .07$, $p = .06$) also predicted the number of comments.

Discussion

This study presented an analysis of field data that demonstrated in an actual marketplace environment (i.e., on the Instagram social media platform) the positive association between presence of symmetry and image contrast on the audience’s response. It is worth noting that due to the nature of the study, the demonstrated relationship was not causal.

Field study’s examination of actual brand-generated social media posts finds that vertical and horizontal symmetry have similar effects on consumer engagement as well as “likes” and comments examined separately in terms of direction and strength. However, image contrast

(when measured via the file size) has a stronger positive correlation with consumer engagement, liking alone, and comments alone than either type of symmetry.

Due to the lack of agreement about how to best measure image contrast (Ortiz-Jaramillo *et al.*, 2018; Panetta *et al.*, 2013; Pedersen *et al.*, 2010), one contribution of the field study is the comparison of two different approaches to measure image contrast – JPEG file size and physical contrast based on luminosity histogram data. Although both produce directionally similar results, file size is clearly a stronger measure, because the compression algorithm incorporates the grayscale value of each pixel into JPEG file, whereas the physical measure only considers the average and peak luminosity in an image.

Because this field study recorded responses to actual Instagram posts, it offers considerable ecological validity. However, unmeasured influences may be affecting relationships between structural properties on consumer responses. For example, Ashley and Tuten (2015) suggest that experiential component and exclusivity - in addition to image factors - may influence consumer responses. On the other hand, experimental study enabled the control of extraneous influences by carefully manipulating symmetry and image contrast, as well as exploring underlying mechanisms of the observed effects. However, due to the nature of the lab experiment, it was impossible to assess the actual consumer engagement with a social media post in a real marketplace. Therefore, the results of two studies must be considered jointly.

General discussion

Previous research has investigated the role of aesthetic responses to visual structural properties in the context of product design (Bloch, 1995; Creusen *et al.*, 2010; van Rompay *et al.*, 2012; Veryzer and Hutchinson, 1998; Wang and Hsu, 2020) and logos (van der Lans *et al.*, 2009;

Wang *et al.*, 2017; Zhang *et al.*, 2017). Unfortunately, prior research offers marketers contradictory advice on designing the most effective images (Kim *et al.*, 2017; Maier and Dost, 2018; Mosteller *et al.*, 2014; Seckler *et al.*, 2015; van der Lans *et al.*, 2009; Wang *et al.*, 2017; Zhang *et al.*, 2017). Also, little work has considered structural properties in social media marketing design. The current study examines two structural properties that appear important to image processing in social media marketing – image contrast and symmetry. To remove the potential for results being attributable to common method variance, different methods were applied. The controlled experiment demonstrates the underlying causal mechanisms of these structural properties’ effects on liking and adds strong internal validity, which enhances the overall contribution, whereas field data of actual brand Instagram posts provides external validity.

From a theoretical perspective, this investigation offers several contributions. First, structural properties of marketing images can affect processing fluency as shown in the current research without altering brand information or advertising content. It contributes to the body of research that has identified characteristics that affect judgments of beauty (Hayn-Leichsenring *et al.*, 2017; Langlois and Roggman, 2017; Zarzosa and Huhmann, 2019). The enhanced processing fluency associated with the presence of symmetry and higher image contrast encourages greater consumer engagement and liking in a social media context. This is a new finding for the literature which extends work that found greater likability for experimental stimuli with symmetry or high figure-ground contrast (Brinol *et al.*, 2006; Reber *et al.*, 1998), and Veryzer and colleagues’ work on symmetry in product design preferences (Creusen *et al.*, 2010; Veryzer and Hutchinson, 1998). Extending this prior research, we directly assess consumer perceptions of processing fluency to add empirical evidence that supports the previously untested, but

theoretical link from the structural properties of symmetry and contrast through processing fluency to aesthetic response, and ultimately to liking. The current results support the processing fluency perspective, which holds that beauty resides not in the object itself, but in the processing experience of the perceiver (Schwarz, 2018). In contrast, traditional theories of aesthetic judgment had presumed that beauty resides in the image itself.

Second, the investigation of the full series of effects from structural properties (symmetry and contrast) to processing fluency to aesthetic response to consumer responses of liking and/or engagement is a major contribution. As shown in Table 1, while some studies had examined parts of this series (most commonly processing fluency on liking), no prior studies investigated the full set of effects. Another contribution of the current research was its demonstration of the power of symmetry and image contrast to elicit consumer responses in complex photographic images. Treder (2010) points out that almost all studies of symmetry perception use simplified artificial stimuli (e.g., dot patterns). Further, prior work on contrast involved figure-ground contrast of simple grayscale stimuli (e.g., circles or words) against a uniform background (e.g., Brinol *et al.*, 2006; Reber *et al.*, 1998; Reber *et al.*, 2004b) rather than global image contrast of photographic images, as in the current research. Thus, current research represents an important step in furthering research on symmetry and image contrast effects.

Third, this investigation also extends earlier theoretical contributions regarding the role of processing fluency in consumer responses to social media marketing with subsequent consequences for marketing practitioners. The current studies expand the list of image characteristics that affect consumer response without changing the denotative meaning of brand information in marketing communications. Other studies have examined the influence on marketing outcomes of image characteristics such as camera angle and vertical versus horizontal

orientation. For example, a product pictured using an upward rather than downward camera angle increases positive attitudes and purchase intentions. Also, purchase intentions improved when a product was pictured in a vertical versus a horizontal orientation (van Rompay *et al.*, 2012).

From a practical perspective, several contributions emanate from this work. In particular, marketers and designers engaged in social media are advised to attend to the structural properties of their images, such as symmetry and contrast. Such structural properties have the potential to influence advertising outcomes beyond the influence communicated through the meaning or interpretation of the image itself. Moreover, social media marketing is an increasingly important way for brands to interact directly with consumers. Thus, skillful use of structural properties when designing images for social media marketing posts should help marketers achieve important brand outcomes, because liking of a marketing message is the best predictor of visual attention (Goller *et al.*, 2019), as well as persuasion and sales (Smit *et al.*, 2006). Prior research has also shown that liking is important because affect can transfer to the advertised brand, especially in low-involvement decision contexts in which liking guides choice and stimulates brand engagement (van der Lans *et al.*, 2009).

Interestingly, Ashley and Tuten's (2015) exploratory content analysis of brand social media pages concluded that some marketers create content with appeals that avoid high cognitive burdens for consumers. This is possibly due to the need to cut through competitive clutter on social media (Ashley and Tuten, 2015). Unfortunately, as shown in the field study, over half of the Instagram images posted by top hotel brands were low contrast or without symmetry, both of which decrease processing fluency. Marketers' use of such images would place a higher

cognitive burden on consumer processing resources. This points to the need for studies such as those in the current research to improve marketing practice.

Areas for further investigation

The current research has some limitations that suggest avenues for future investigations. First, while the experimental study referenced “social media” in general, the field study analyzed data from a particular social media platform (Instagram). Also, both studies focused on consumer responses to social media images for experience products (vacation destinations in the experiment and hotel chains in the field study) within the travel and tourism industry. Future studies could investigate consumer engagement generated by the images appearing on different social media platforms (e.g., Twitter or Snapchat) or from different industries (e.g., consumer packaged goods). Also, search and experience products differ in information sought for evaluation (Franke *et al.*, 2004), online browsing behavior, and loyalty when satisfied with a brand’s social media sites (Lim *et al.*, 2015). Thus, future research should compare consumer responses to social media images for search and experience products or attributes.

Second, to ensure internal validity, symmetry and contrast were studied using only 1:1 ratio, square images. Future research should extend this study into different formats (e.g., rectangular or circular images with different ratios) as well as the potential of other structural properties of images (e.g., complexity, harmony, balance, focality, or unity) to enhance processing fluency and aesthetic response to the benefit of attitudinal and behavioral responses to the marketing image and the advertised product.

Third, the results suggest the need for further investigations into metacognitive processes driving consumers’ aesthetic judgments of beauty in the online context. Given the parallels

between beauty-related and truth-related consumer judgments, future studies might assess if image-centric brand posts that are easier to process due to symmetry or high contrast will result in higher trustworthiness perceptions toward the brand or brand communications (Schwarz, 2018). Further, increased use of video content on social media (Karhoff, 2018) and even in marketing academia (Belk and Kozinets, 2018) suggests needed investigation into antecedents of processing fluency, aesthetic response, and liking of video content.

Fourth, the current research demonstrated contrast and symmetry effects on judgments of beauty, but future research could investigate how contrast, symmetry and/or other structural properties' influence on beauty judgments leads to difference in perceptions of product quality or luxury. This area remains largely unexplored (Creusen *et al.*, 2010). For example, the current research showed that symmetry and higher contrast images improved aesthetic responses, which might be predicted to increase quality and luxury perceptions. However, future research could also explore anomalies or limiting cases, such as practitioner observations that bright colors in images or bright lights in service or retail environments, which should increase visual contrasts and, hence, processing fluency, tend to lead to consumer perceptions that of low luxury or quality. Future research might explore this in terms of a non-monotonic relationship between contrast and luxury or quality perceptions, such that stimuli which are too easy or too difficult to process are perceived as lower in luxury or quality than stimuli with an optimal level of contrast. Such non-monotonic relationships have been observed with structural properties for other consumer responses in other contexts (see Huhmann, 2008 for review).

A fifth potential area for future research involves investigation of the degree to which responses to structural properties varies with consumer personality and demographics. For example, prior research has found that those higher (lower) in social dominance respond more

positively (negatively) to vertical image backgrounds (van Rompay *et al.*, 2012). The relationship to social dominance as a personality trait arises because vertical orientations relate to success or power perceptions. Responses to the structural properties investigated in the current research – symmetry and contrast – may also vary with personality. For example, those with a greater tolerance for ambiguity might be more accepting of images with lower contrast. Similarly, education level and social class have been shown to influence aesthetic responses toward design complexity, image contrasts, and color saturation. For example, lower class adolescents had more favorable aesthetic responses toward higher contrast, less complex designs with saturated colors than did middle class adolescents (Heinrichs and Cupchik, 1985; Knapp *et al.*, 2010). Finally, those with higher optimal stimulation levels might prefer social media images with asymmetry and less image contrast due their preference for more irregularity; novelty; and unconventional elements (Bloch, 1995), such as the grotesque or the antithetical aesthetic (Zarzosa and Huhmann, 2019). Future research should investigate demographic differences in response to symmetry and contrast, and any mediating effect of processing fluency.

A sixth area of investigation relates to the brand personality. Luffarelli *et al.* (2019) found that asymmetrical (vs. symmetrical) logos benefitted brand evaluations for more energetic and exciting brands. This topic could be further pursued in the context of structural properties of social media posts by the brands with varying personalities.

Yet another direction for future research concerns online retailing implications of structural properties. Structural properties that increase processing fluency, such as symmetry and higher image contrast, might retain web traffic for longer on an online retail website and increase the likelihood that online shoppers will complete transactions rather than abandon their shopping carts.

Lastly, the images in the current research employed mirror symmetry. Other research that explored non-mirror symmetry images of symmetrical objects found no relationship between non-mirror symmetry images of symmetrical objects and subjective ratings of aesthetic appeal (Lai *et al.*, 2010). Future research should try to explicate this contradictory finding with regard to aesthetic responses between mirror and non-mirror symmetry.

Table I. Contribution of research investigating relationships of symmetry, contrast, processing fluency, and aesthetic response.

Research	Study	N	Symmetry			Contrast			Processing fluency		Aesthetic response
			Fluency	Liking	Engagement	Fluency	Liking	Engagement	Aesthetic response	Liking	
Current research	Study 1	361	+	+		+	+		+		+
	Study 2	610		+	+		+	+			
Berlyne (1974)	Chapter 1										C
	Chapter 5	24									+
	Chapter 9										+
Reber <i>et al.</i> (1998)	Study 2	31									+
	Study 1	53							+		
	Study 2	36					+				
Reber <i>et al.</i> (2004a)	Study 3	20							+		
			C	C		C			C	C	
	Study 1	48				+					
Brinol <i>et al.</i> (2006)	Study 2	83					+				
Labroo and Pocheptsova (2016)									C	C	
Karaosmanoglu and Altinigne (2017)		303									+
Maier and Dost (2018)	Study 2	42				-	-				+
	Study 3	295				-	-				+
Schwarz (2018)			C			C			C		
Maier (2019)	Study 1	44									+
	Study 2	81									+
Marin <i>et al.</i> (2019)	Study 1	203									+
Zarzosa and Huhmann (2019)	Study 3	172									+

Note: ^a Processing fluency not directly measured. Relationships are conceptual (C) and positive (+) or negative (-) empirical outcomes.

Table II. Symmetry, contrast, aesthetic response (AR) and processing fluency (PF) on consumer response to online marketing messages

Authors (Year). Location	Study type and sample size	Context	Symmetry, contrast, AR or PF	Outcome(s)	Findings
Current research. U.S.	361 Ss viewed social media marketing images for travel destinations in a between-Ss experiment (Study 1). Consumers' engagement ("likes" and comments) responses elicited by 610 Instagram posts for hotel brands were examined in a field study (Study 2).	Social media posts	Symmetry, contrast, AR and PF	Liking and consumer engagement	Greater image contrast as well as horizontal and vertical symmetry improve liking and engagement. Study 1 finds PF's influence on AR serially mediate effects on liking.
Auschaitrakul and Mukherjee (2017). U.S.	125 MTurk Ss (Study 1) and 130 MTurk Ss (Study 2) viewed ads on websites in between-Ss experiment.	Online display ads	PF	Brand attitude	PF mediates website type's effect on brand attitude.
Chen <i>et al.</i> (2019). China	Structural equation model. 251 online panel Ss surveyed about product recommendations in WeChat posts.	Social media posts	AR	Product affection and urge to buy impulsively	AR directly and indirectly (through product affection) effects urge to buy impulsively.
Huang <i>et al.</i> (2018). China, U.S.	211 online panel Ss (Study 1) and 203 MTurk Ss (Study 2) saw negatively or positively valenced online reviews written in an easy vs. difficult-to-read font. 100 student Ss (Study 3) saw positively-valenced online reviews in an easy- or difficult-to-read font where they either had to be accountable for their evaluation or not.	Online reviews	PF	Product evaluation	Less readable reviews weakened the effect of review valence on evaluation. When Ss had to justify their evaluation, difficult-to-read fonts heightened evaluations of products with positively-valenced reviews.
Karaosmanoglu and Altinigne (2017). Turkey	303 MTurk Ss viewed a landing page for an online retailer with high or low visual complexity in between-Ss experiment.	Retail website	PF	Enjoyment	Less visually complex webpages are more enjoyable than more complex webpages. PF moderates this relationship.
Kim <i>et al.</i> (2017). China	Structural equation model. 212 Chinese Sina Weibo users surveyed about a tourism page. They rated the content and non-content factors (e.g., webpage design attractiveness) and provided perceptions of the cognitive, affective, and conative image of the social media page.	Social media page	AR	Cognitive, affective, conative images of the social media page.	Of the non-content factors, AR had a positive direct effect on cognitive image, but not affective image, and a positive indirect effect on conative image.
Kostyk <i>et al.</i> (2017). U.S.	73 MTurk Ss (Study 1), 102 MTurk Ss (Study 2), and 156 MTurk Ss (Study 3) saw the full distribution or weighted average of online consumer ratings on a hotel booking website in between-Ss experiments.	Online consumer ratings	PF	Purchase intentions	Purchase intentions were higher for online ratings when presented in a mean than a distribution format. PF mediates this relationship via indirect-only mediation.

Maier (2019). Germany	Within-Ss experiments. Study 1: 44 managers saw 6 consistent orientation or background sets and 6 inconsistent sets of product images. Study 2: 81 graduate students saw 6 consistent orientation and 6 inconsistent sets of product images.	Online product images	PF	Liking and choice satisfaction	PF positively influences liking and choice satisfaction. PF also mediates inconsistency's influence on liking and choice satisfaction.
Maier and Dost (2018). Germany	Within-Ss experiment. 42 MBA students saw products on either a white (e.g., a bed against a white field) or appropriate contextual (e.g., a bed in a bedroom) background. Between-Ss experiment. 295 MTurk Ss viewed a wine rack against a white vs. contextual background.	Online product images	Contrast, PF	Liking	Contrary to most research on contrast, the lower figure-ground contrast with a product in contextual background improved liking. This relationship was mediated by PF.
Mosteller <i>et al.</i> (2014), U.S.	Between-Ss experiment. 299 students viewed an online product comparison webpage with easy- or difficult-to-read font in black text on either a white or gray background. Products either had 5 or 15 attributes (i.e., information intensity). PF was manipulated via font clarity, figure-ground contrast, and information intensity.	Product comparison webpage	Contrast, PF	Cognitive effort, affect, and choice satisfaction	Although lower contrast reduced PF, it did not combine with clarity and information intensity in PF perceptions. PF reduced cognitive effort required to complete the shopping task, and increased positive affect. Cognitive effort negatively and positive affect positively influenced satisfaction.
Seckler <i>et al.</i> (2015). Switzerland	Within-Ss experiments. 33 students viewed either symmetrical or asymmetrical company websites. 54 students viewed company websites with either low or high visual complexity. Ss rated subjective aesthetic perceptions of simplicity (easy to grasp, everything goes together), diversity (inventive and pleasantly varied layout), colorfulness (attractive color composition vs. colors do not match), and craftsmanship (layout looks up-to-date, professionally designed, and designed with care).	Company websites	Symmetry	Subjective aesthetic perceptions of simplicity, diversity, colorfulness, and craftsmanship.	Symmetry was directly related to perceptions of simplicity, diversity, and craftsmanship. Visual complexity was inversely related to perceptions of simplicity, diversity, colorfulness, and craftsmanship.
Sohn <i>et al.</i> (2017). Germany	233 students randomly assigned to a 2 (animation: low vs. high) \times 2 (contrast: low vs. high) \times 2 (smartphone vs. tablet) between-Ss design. High animation and low contrast were used to increase perceptions of visual complexity.	Mobile shopping site	Contrast	Satisfaction	Complexity negatively affected satisfaction when Ss viewed the site on a tablet, but not a smartphone. Complexity increased perceived visual crowding when Ss viewed the site on the smartphone, but not the tablet. Visual crowding mediated the complexity-satisfaction relationship for smartphone but not tablet users.

Table III. Experimental study results (Study 1)

Effect	<u>Vertical Symmetry</u>		<u>Horizontal symmetry</u>	
	Statistical test	Hypothesis test	Statistical test	Hypothesis test
<u>Multivariate analysis of variance</u>				
Symmetry x contrast interaction → LIKE, AR and PF	$F(3, 355) = 2.14$; Wilks' $\Lambda = .98$, partial Eta squared = .018		$F(3, 355) = 2.81$, Wilks' $\Lambda = .98$, partial Eta squared = .023*	
Symmetry → LIKE	<u>Main effect</u> $F(1,359) = 7.9^{**}$	H1a: Supported	<u>Simple effects</u> Under low contrast: $F(1,179) = 5.9^*$ Under high contrast: $F(1,178) = 14.9^{***}$	H1b: Supported
Contrast → LIKE	<u>Main effect</u> $F(1,359) = 10.6^{***}$	H2: Supported	<u>Simple effects</u> Under symmetry absent: $F(1,183) = 8.9^{**}$ Under symmetry present: $F(1,174) = 17.2^{***}$	H2: Supported
<u>PROCESS model</u>				
Indirect-only serial mediation: Symmetry → PF → AR →LIKE	$\beta = 0.18$, $SE = .08$, CI [.05, .38]	H3: Supported	$\beta = 0.12$, $SE = .07$, CI [.01, .29]	H3: Supported
Indirect-only serial mediation: Contrast → PF → AR →LIKE	$\beta = 0.13$, $SE = .08$, CI [.002, .31]	H4: Supported	$\beta = 0.17$, $SE = .08$, CI [.05, .36]	H4: Supported

Note: Abbreviations are Liking (LIKE), Aesthetic response (AR), and Processing fluency (PF). Simple effects appear when a significant interaction supersedes the main effects. $*p \leq .05$, $**p \leq .01$, $***p \leq .001$.

Table IV. Use of symmetry in brand Instagram posts

Brand	<u>Posts with symmetry</u>			<u>Posts without symmetry</u>			<u>Total posts</u>
	Observed	Expected		Observed	Expected		<i>n</i>
	count	count	%	count	count	%	
Marriott	33	22.4	47.1 ^a	37	47.6	52.9 ^a	70
Hilton	35	22.4	50.0 ^a	35	47.6	50.0 ^a	70
Fairmont	20	19.2	33.3 ^{a, b, c}	40	40.8	66.7 ^{a, b, c}	60
Hyatt	15	22.4	21.4 ^{b, c}	55	47.6	78.6 ^{b, c}	70
Mandarin Oriental	15	19.2	25.0 ^{a, b, c}	45	40.8	75.0 ^{a, b, c}	60
Four Seasons	26	22.4	37.1 ^{a, c}	44	47.6	62.9 ^{a, c}	70
Omni Hotels	9	22.7	12.7 ^b	62	48.3	87.3 ^b	71
Shangri-La	18	22.7	25.4 ^{a, b, c}	53	48.3	74.6 ^{a, b, c}	71
Taj	24	21.7	35.3 ^{a, b, c}	44	46.3	64.7 ^{a, b, c}	68

Note: $\chi^2 = 37.6$, $df = 8$, $p < .01$; $\Phi = 0.25$, $p \leq .01$

^{a, b, c} Each subscript letter denotes a subset of brands whose proportions of posts with/without symmetry do not differ from each other ($p \leq .05$) based on *z*-tests.

Table V. Use of image contrast in brand Instagram posts

Brand	<u>Posts with low contrast</u>			<u>Posts with high contrast</u>			<u>Total posts</u>
	Observed count	Expected count	%	Observed count	Expected count	%	<i>n</i>
Marriott	31	34.9	44.3 ^{a, b}	39	35.1	55.7 ^{a, b}	70
Hilton	33	34.9	47.1 ^{a, b}	37	35.1	52.9 ^{a, b}	70
Fairmont	26	29.9	43.3 ^{a, b}	34	30.1	56.7 ^{a, b}	60
Hyatt	37	34.9	52.9 ^{a, b}	33	35.1	47.1 ^{a, b}	70
Mandarin Oriental	33	29.9	55.0 ^{a, b}	27	30.1	45.0 ^{a, b}	60
Four Seasons	20	34.9	28.6 ^b	50	35.1	71.4 ^b	70
Omni Hotels	34	35.4	47.9 ^{a, b}	37	35.6	52.1 ^{a, b}	71
Shangri-La	43	35.4	60.6 ^a	28	35.6	39.4 ^a	71
Taj	47	33.9	69.1 ^a	21	34.1	30.9 ^a	68

Note: $\chi^2 = 29.13$, $df = 8$, $p \leq .001$; $\Phi = 0.22$, $p \leq .001$

^{a, b} Each subscript letter denotes a subset of brands whose proportions of posts with low/high contrast do not differ from each other ($p \leq .05$) based on *z*-tests.

Figure 1. Theoretical framework

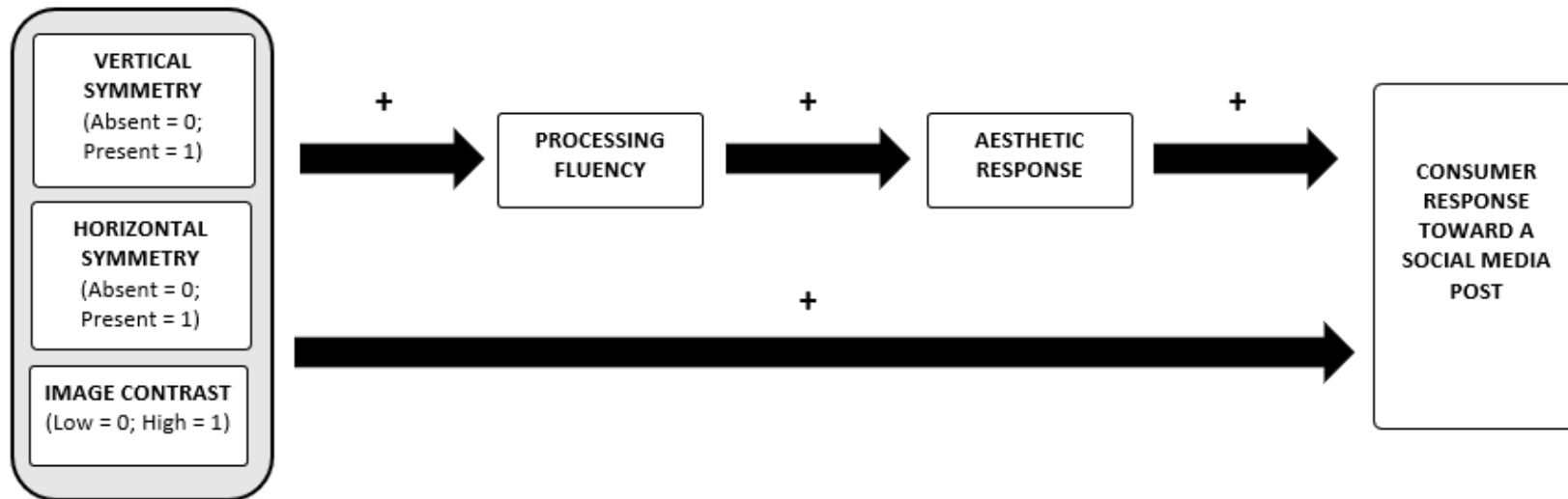


Figure 2. Horizontal (top panel) and vertical (bottom panel) symmetry manipulation



Note: Images represent high contrast experimental condition. Low contrast experimental condition featured the same images with -50% reduced contrast as produced by the Microsoft Photos software.

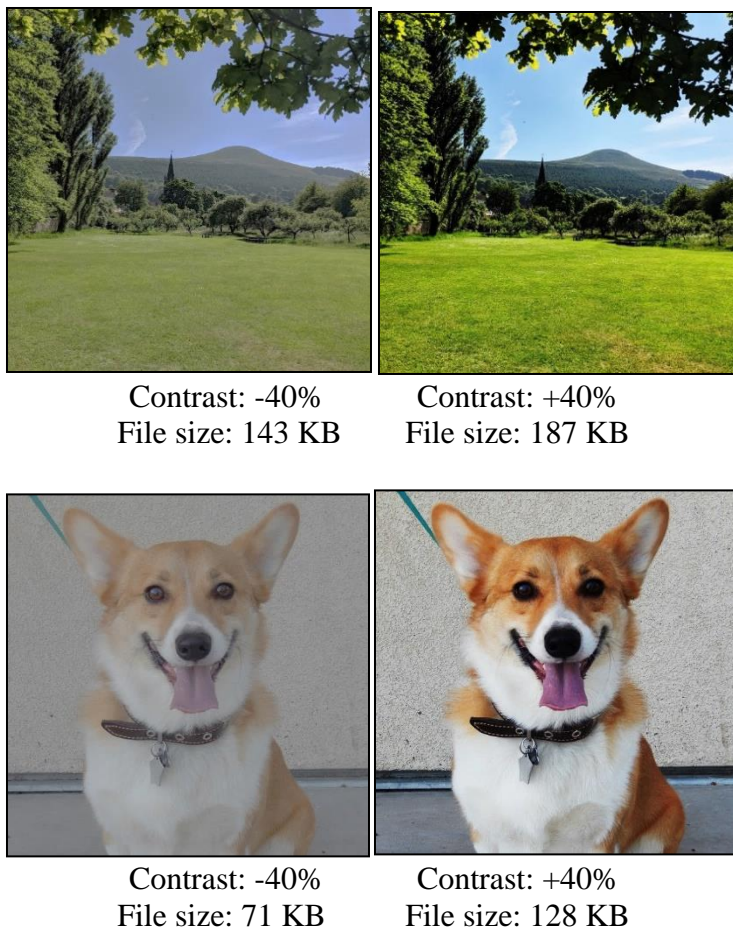


Figure 3. Differential image contrast for 600 x 600-pixels images

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